EXPERIMENTAL INVESTIGATION ON CEMENT MORTAR USIG FLYASH BASED GEOPOLYMER AS AN ALTERNATIVE TO CEMENT

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ABSTRACT:

Cement usage around the world is second only to water. Ordinary Portland cement (OPC) is conventionally used as the primary binder to produce concrete. The environmental issues associated with the production of OPC are well known.The amount of the carbon dioxide released during the manufacture of OPC due to the calcination of limestone and combustion of fossil fuel is in the order of one ton for every ton of OPC produced.

Geopolymer materials represent an innovative technology that is generating considerable interest in the construction industry, particularly in light of the ongoing emphasis on sustainability. In contrast to Portland cement, most geo-polymer systems rely on minimally processed natural materials or industrial byproducts to provide the binding agents. Since Portland cement is responsible for upward of 85 percent of the energy and 90 percent of the carbon dioxide attributed to a typical ready-mixed concrete, the potential energy and carbon dioxide savings through the use of geopolymers can be considerable. Consequently, there is growing interest in geopolymer applications in transportation infrastructure.

The environmental issues associated with the production of OPC are well known.The amount of the carbon dioxide released during the manufacture of OPC.In addition, the extent of energy required to produce OPC is only next to steel and aluminum.

The main objective of this investigation is to replace the OPC completely in mortar and to use waste materials like fly ash to prepare geo polymer mortar in ambient curing conditions.

I.INTRODUCTION

Cement usage around the world is second only to water. Ordinary Portland cement (OPC) is conventionally used as the primary binder to produce concrete. The environmental issues associated with the production of OPC are well known. The amount of the carbon dioxide released during the manufacture of OPC due to the calcination of limestone and combustion of fossil fuel is in the order of one ton for every ton of OPC produced.

On the other hand, the abundant availability of fly ash worldwide creates opportunity to utilize this by-product of burning coal, as a substitute for OPC to manufacture cement products. When used as a fully replacement of OPC, in the presence of water and in ambient temperature, fly ash reacts with the calcium hydroxide during the hydration process of OPC to form the calcium silicate hydrate (C-S-H) gel. The development and application of high volume fly ash cement, which enabled the replacement of OPC up to 60% by mass is a significant development.

Geopolymer materials represent an innovative technology that is generating considerable interest in the construction industry, particularly in light of the ongoing emphasis on sustainability. In contrast to Portland cement, most geo-polymer systems rely on minimally processed natural materials or industrial byproducts to provide the binding agents. Since Portland cement is responsible for upward of 85 percent of the energy and 90 percent of the carbon dioxide attributed to a typical ready-mixed concrete, the potential energy and carbon dioxide savings through the use of geopolymers can be considerable. Consequently, there is growing interest in geopolymer applications in transportation infrastructure.

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This is the details of thesis use of fly ash in any construction work as a replacement of cement, provides lower impact on environment (reduce CO_2 emission) and judicious use of resources (energy conservation, use of by-product)

Use of fly ash reduces the amount of cement content as well as heat of hydration in a mortar mix. Thus, the construction work with fly ash cement becomes environmentally safe and also economical.

II. Constituents of Geopolymer Cement

1. Fly Ash

Fly ash obtained from Yerraguntla thermal power station (RTPP) is used in the preparation of geo polymer mortar. Chemical properties of fly ash used are given below.

Binder	LOI	Al_2o_3	Fe_2O_3	SiO_2	MgO	SO3	Na2O	Chlorides	Cao
Fly ash	0.9	31.3	1.5	61.12	0.75	.53	1.35	0.06	3.2

Table 1.1 chemical composition of fly ash

Fly ash is one of the residues generated in the combustion of coal. Fly ash is generally captured from the chimneys of power generation facilities. Fly ash consists of fine, powdery particles that are predominantly spherical in shape, either solid or hollow, and mostly glassy (amorphous) in nature. The carbonaceous material in fly ash is composed of angular particles. The particle size distribution of most bituminous coal fly ashes is generally similar to that of silt (less than a 0.075mm).

In addition to economic and ecological benefits, the use of fly ash in concrete improves its workability, reduces segregation, bleeding, heat evolution and permeability, inhibits alkali-aggregate reaction, and enhances sulfate resistance.

Class C Fly Ash

Fly ash produced from the burning of younger lignite or sub-bituminous coal, in addition to having pozzolanic properties, also has some self-cementing properties. In the presence of water, Class C fly ash will harden and gain strength over time. Class C fly ash generally contains more than 20% lime (CaO). Unlike Class F, self-cementing Class C fly ash does not require an activator. Alkali and sulfate (SO_4) contents are generally higher in Class C fly ashes. Class C fly ash usually has cementitious properties in addition to pozzolanic properties due to free lime, whereas Class F is rarely cementitious when mixed with water alone.

Table 3.2 Chemical Components Of Fly Ash Obtained From Various Types Of Coal

Components	Bituminous coal (%)	Sub-Bituminous coal (%)	Lignite coal (%)
SiO_2	20-60	40-60	15-45
Al_2O_3	5-35	20-30	20-25
Fe_2O_3	10-40	4-10	4-15
CaO	1-12	5-30	15-40
Loss of Ignition	0-15	0-3	0-5

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III. Geopolymers

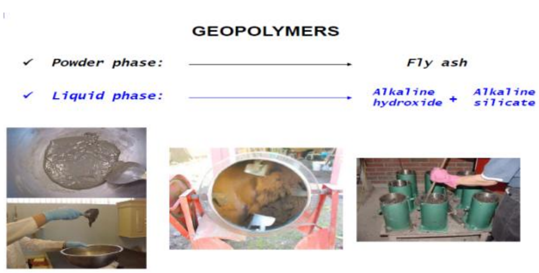
Alkaline liquid could be used to react with the silicon (Si) and the aluminium (Al) in a source material of geological origin or in byproduct materials such as fly ash and rice husk ash to produce binders. Because the chemical reaction that takes place in this case is a polymerization process, the term 'Geopolymer' is used to represent these binders. Geopolymers are members of the family of inorganic polymers. The chemical composition of the geopolymer material is similar to natural zeolitic materials, but the microstructure is amorphous instead of crystalline.

Preparation of Geopolymer Mortar

Following materials are generally used to produce GPCMs:

- Fly ash
- Fine aggregates
- Fly Ash- rich in Silica and Aluminium
- Sodium Hydroxide or Potassium Hydroxide

Sodium Silicate or Potassium Silicate



Materials of OPC Mortar

Cement:

53-grade ordinary portland cement (Zuari) conforming to IS:12269-1987 was used. the physical properties and chemical composition of major compounds of cement are given in Tables

Water:

De-ionised water was used as mixing water for making and curing test specimens. the characteristics of deionised water.

Sand:

Ennore sand conforming to IS:650-1966 was used. physical properties are given in

The cement to fine aggregate ratio was maintained at 1:3(byweight)in the mortar mixes

IV. RESULTS

Table 4.1 Comparison of Geo polymer cement($Na_2SiO_3/NaOH$ 2 Ratio and 2.5 Ratio)

DAYS	COMPRESSIVE STRENGTH(N/mm2) 2 Ratio	COMPRESSIVE STRENGTH(N/mm2) 2.5 Ratio
3 days	13	15
7 days	26	29
14 days	33	36
28 days	42	44

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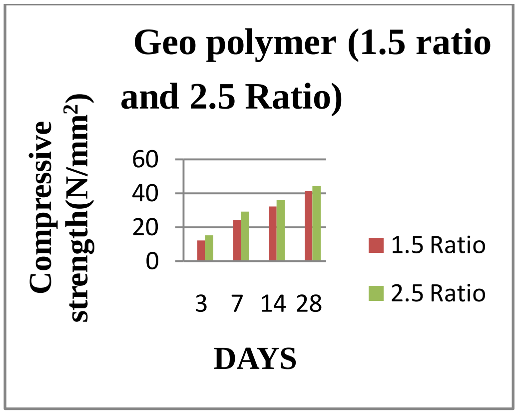

Figure 4.2 Graphical representation of compressive strength values of geo polymer mortar with different ratios.

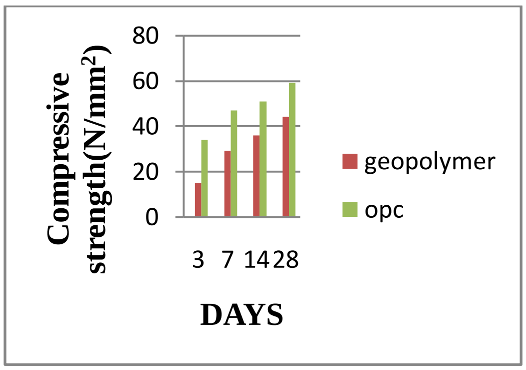

Figure 4.3 Graphical representation of compressive strength values of geo polymer cement and OPC

V.CONCLUSION

- Geopolymer mortar develops sufficient strength even in ambient temperature conditions without any conventional curing, an encouraging outcome of the study
- Geo polymer mortar can emerge as an eco friendly and sustainable construction material and can be used for the manufacture of compressed blocks/pavers
- It is observed that geopolymer mortar in ambient curing conditions can obtain good strength in 28 days..
- Higher concentration (in terms of molarity) of sodium hydroxide solution results in higher compressive strength of fly ash-based geo polymer mortar.
- Workability of geopolymer mortar decreases with the increase in concentration of sodium hydroxide.
- Water content proved to be crucial parameter to retain mortar as workable but geo polymer mortar without water was too dry.
- 18% to 30% economy is achieved in geo polymer mortar when compared to cement mortar.
- It is observed that geopolymer mortar in ambient curing conditions can obtain good strength in 28 days
- The rate of gain in strength of fly ash mortar specimens in observed to lower than the Corresponding OPC mortar.
- Higher concentration (in terms of morality) of sodium hydroxide solution results in higher compressive strength of fly ash-based geo polymer mortar
- Workability of geopolymer mortar decreases with the increase in concentration of sodium hydroxide
- 18% to 30% economy is achieved in geopolymer mortar when compared to cement mortar.
- Compressive strength of geopolymer mortar is nearly 70% of cement mortar.
- Use of fly ash reduces the amount of cement content as well as heat of hydration in a mortar mix. Thus, the construction work with fly ash cement mortar becomes environmentally safe and also economical.
- From economy and from strength point of view take ratio of alkaline solution

  (Na_2SiO_3/NaOH) as 2.5.

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